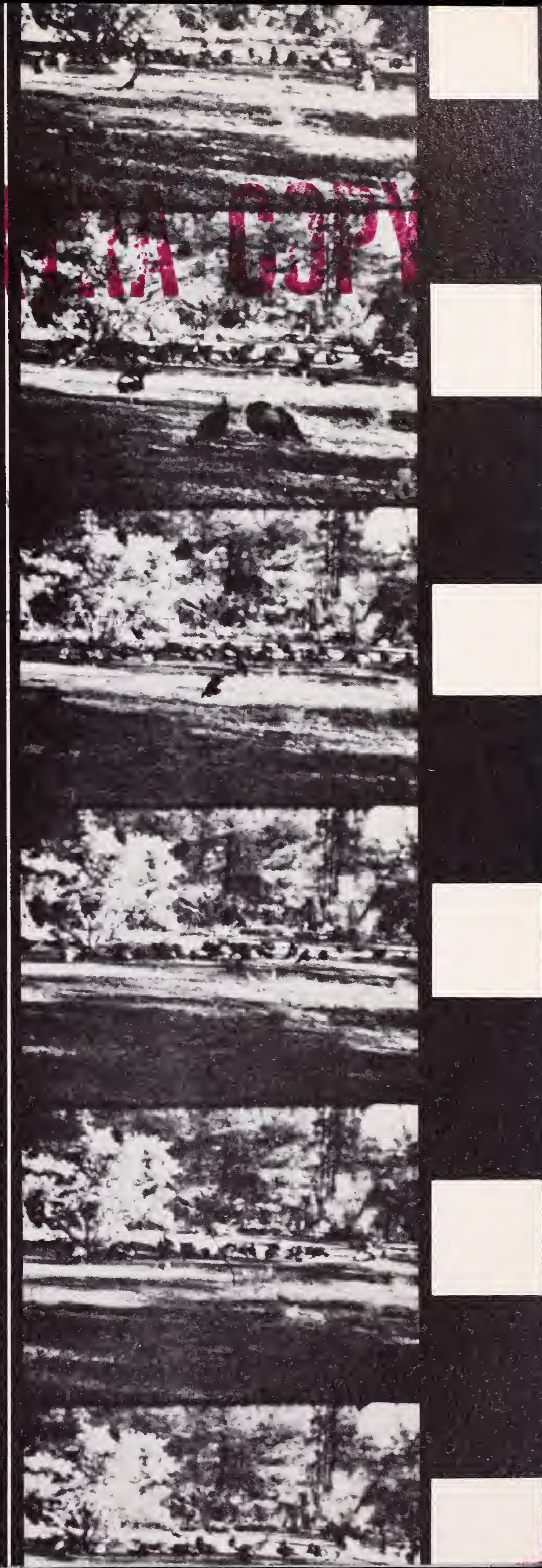

CONSTRUCTION OF AN 8-MM TIME-LAPSE CAMERA FOR BIOLOGICAL RESEARCH

by David R. Patton, Virgil E. Scott, and Erwin L. Boeker

USDA Forest Service
Research Paper RM-88

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Rocky Mountain Forest and
Range Experiment Station

Forest Service

U. S. Department of Agriculture

Fort Collins, Colorado

Abstract

A time-lapse camera for use in biological research can be constructed from a super 8-mm movie camera. A single-frame release is activated through a solenoid controlled by an electronic timer. The unit is activated by a photo cell for daylight operation. Timing interval can be varied from 1/2 second to 60 minutes. With a 5-minute interval and 12 hours of daylight, one roll of film will last 25 days. The unit operates from a 6-volt d.c. power supply. Cost of camera, solenoid, and electronic timer is approximately $165.

Keywords: Wildlife techniques, biological research, time-lapse photography.

Acknowledgments

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Construction of an 8-mm Time-Lapse Camera for Biological Research

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David R. Patton, Wildlife Biologist

Rocky Mountain Forest and Range Experiment Station[1]

Virgil E. Scott, and Erwin L. Boeker, Research Biologists

Bureau of Sport Fisheries and Wildlife[2]

[1] Forest Service, U. S. Department of Agriculture, with central headquarters maintained at Fort Collins, in cooperation with Colorado State University. Patton is located at Tempe, in cooperation with Arizona State University.

[2] Fish and Wildlife Service, U. S. Department of The Interior, with regional headquarters at Wildlife Research Center, Denver, Colorado. Scott and Boeker are permanently assigned to field station headquarters at Tempe, Arizona.

Contents

Construction of an 8-mm Time-Lapse Camera for Biological Research

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Introduction

Time-lapse photography is a valuable technique to replace observers in certain types of wildlife research. It compresses the time of a scene into a shorter viewing period; it is an instantaneous and systematic sample of an event. A review of technical data on commercial devices that met our specifications revealed most were too expensive (from $400-$1,200), and were not adapted to field use. It became apparent that if we wanted to use time-lapse photography in wildlife research, we would first have to develop the equipment. This Paper presents one method for constructing an 8-mm time-lapse camera.

The time-lapse unit consists of a Vivitar [3] Super 8-mm movie camera with an electric motor, behind-the-lens light meter, automatic "f" stop, and 50-foot film cartridge. The single-frame release is activated by a solenoid attached to the side of the camera and controlled by an electronic timer.

During daylight hours the unit is turned on by a photo cell. The camera, timer, and solenoid are encased in a weatherproof aluminum box (fig. 1). Power is provided by a 6-volt battery. Any camera with a single-frame release or an electromagnetic shutter can be used with the timer and solenoid. Choice of camera will depend on the cost and operational features needed by the researcher.

[3] *Trade names and company names are used for the benefit of the reader and do not imply endorsement or preferential treatment by the U. S. Department of Agriculture.*

Construction Details

Weatherproof Case

The camera case is constructed from a deep drawn aluminum box (fig. 2). Holes are cut in the ends for a glass or plastic lens. Suitable lenses can be obtained from surplus meters or flashlights. Lenses are held in place with epoxy cement or a lens mount with screws. A hole for the solar unit is cut below the front lens. Two screws hold a cover over the side of the case.

A sheet of 1/16- x 8- x 9-inch aluminum is attached to the outside of the case by screws or rivets. Holes (1/4 inch) spaced at 1-inch intervals are drilled at the top and bottom. These holes are helpful when positioning the camera on a post or tree. Inside the case, a piece of plywood (1/2 x 1-1/2 x 3-1/2 inches) is glued to the side. The camera is held against the plywood by a No. 12-20 x 1/4-inch screw going through the top of the case into a light socket on top of the camera.

Figure 1.—Time-lapse camera in an aluminum case.

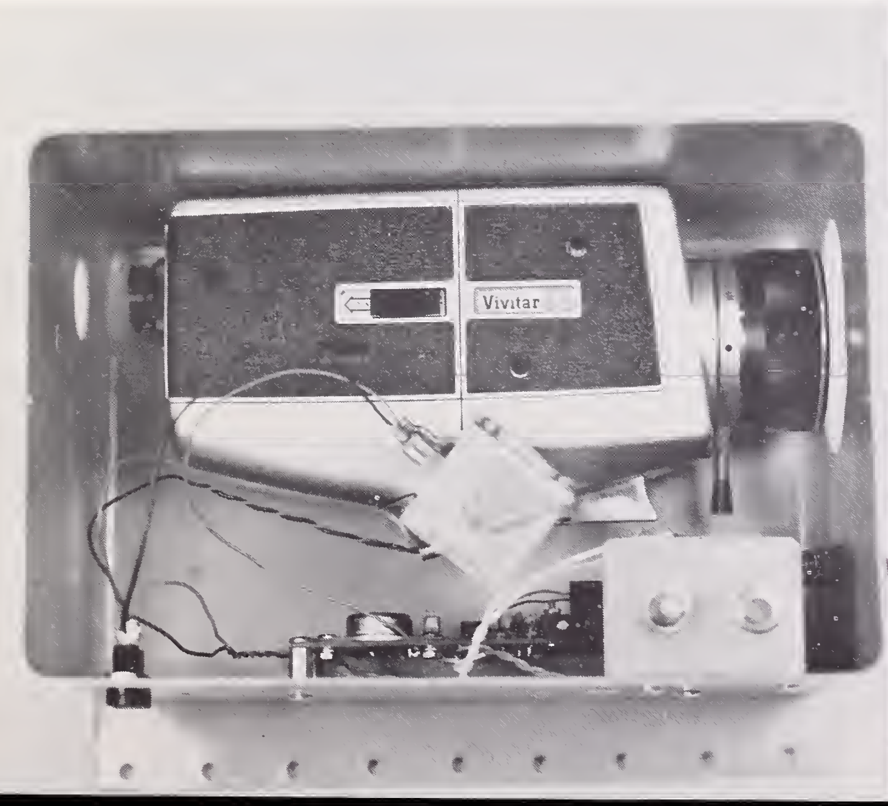
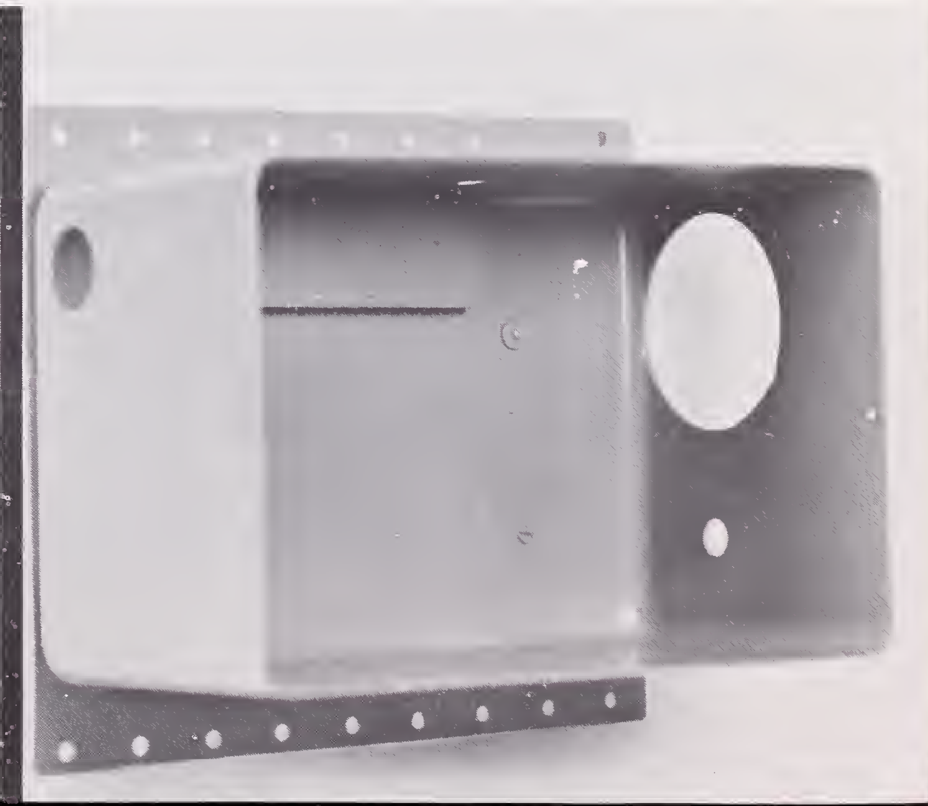


Figure 2.—Camera case constructed from aluminum box.



Holes for banana plug receptacles are drilled near the back of the case. Locations of the timer and control panel are not critical. Screw holes for locating these parts can be drilled after the camera has been positioned inside.

The aluminum box with a tight-fitting side cover makes a good weatherproof container. An alternative is to use plywood and coat it with epoxy resin. A piece of 1 2- x 20- x 20-inch plywood contains enough material to construct the case. Table 1 lists parts for the camera and case.

Electronic Timer

The electronic timer is constructed on a fiberglass board or printed circuit. Holes are drilled in the board so wire leads from the components can be connected on the underside according to the schematic (fig. 3). Components (table 2) are identified and located on the board as shown in figure 4 (gray lines show the actual connections).

There are five sets of connections leading from the timer: the power source, solenoid, reset, voltage control, and photo cell. All wire connections should be stranded No. 22 wire. A button switch and variable resistor (R25) are mounted on a control panel and located near the front of the case (fig. 1). Wires from the button switch connect to the reset points. The variable resistor connects to the points labeled R25 on the layout.

Two wires, one red (positive) and one black (negative) lead from the timer to two banana plug receptacles at the rear of the case. Receptacles also should be red and black. Solenoid wires from the timer have female connections that fit the flat terminals of the solenoid. Camera and photocell connections are identified on the layout and schematic.

Care must be taken to insure the positive (red) wire from the camera is connected to the positive banana plug receptacle. It is helpful if the pairs of connections from the timer to the photo cell, reset button, and R 25 are color coded.

Table 1.—Parts list for camera and case

Description	No. Needed	Approximate Cost
Camera, Super 8-mm, Vivitar Model 83	1	100.00
Aluminum box (Zero No. Z96-144-80)	1	6.95
Al. cover (Zero No. Z96-144-COT-1/2)	1	2.95
Screws, No. 8-32 x 1/4	16	.48
Screw, No. 12-20 x 1/4	1	.04
Nuts, No. 8-32	6	.18
Aluminum sheet, 1/16" x 8" x 9"	1	.50
Aluminum sheet, 1/16" x 1" x 1-1/2"	1	—
Lens, glass or plastic 2-3/4" dia. (minimum)	1	.30
Lens, glass or plastic 1-1/2" dia. (minimum)	1	.15
Plywood, 1/2" x 1-1/2" x 3"	1	—
Cork, 1/8" x 1/2" dia.	1	—
Solenoid, Dormeyer B24-255-A1	1	4.25
Cable, 2 conductor (red & black), stranded No. 22	10 ft.	1.25
Welding rod, 1/16" x 3"	1	—
Receptacles, banana plug	4	1.00
Jacks, banana plug	4	1.00
Cartridge case, ammo, 50 mm (surplus)	1	1.50
Spray paint, epoxy (Sears)	1	1.50
Conductor, quick disconnect (push-on type, female)	2	.10
	TOTAL	$122.15

The timer is mounted inside the case near the front of the camera on four 1/2-inch spacers. As a precaution against moisture, the timer can be sealed in potting compound or sprayed with plastic.

Photo Cell

Day operation of the camera is controlled by a photoelectric cell mounted below the camera lens and connected to the timer by wire leads. The cell is inserted in a holder behind a clear lens with a frosted back. A bayonet base for the photo cell is made from a T-1, 3/4 midget lamp. Glass is broken from the lamp and resin cleaned from inside the base. The cell is soldered to the base at the same points as was the lamp filament. Leads of the cell soldered to the base must be long enough so the cell just touches the glass of the cover lens. Parts for the photoelectric unit are listed in table 2.

Camera Modification

The Vivitar camera is modified to fit inside the aluminum case by removing the pistol grip handle. Two screws hold the handle to the camera base. When these screws are removed, the handle can be pulled from the camera and the connecting wires exposed.

The three wires (red, black, and white) in the handle should be disconnected and soldered to 6-inch leads so they may be connected to the power source. Both the red and white wires are positive and can be connected to one red wire. The white wire provides power to the automatic "f" step. On new models this wire may not be present.

Solenoid Modification for Single-Frame Release

A Dormeyer No. B24-255A1 solenoid is modified for use as the activator of the single-frame release. The flat end of the plunger is cut off at the end of the slot (fig. 5). The sharp end of the plunger also is cut off about 1/8 inch so that it can be drilled for insertion of a plunger pin. The end of the solenoid also must be drilled with a hole large enough to allow passage of the pin. An easy way to drill the solenoid and plunger for a good fit is to drill them both at the same time in a vise.

The plunger, after the ends have been cut off, is inserted in the solenoid and clamped in a vise so the plunger does not move. A hole is then drilled through the nubbin at the end of the solenoid and 1/4 inch into the plunger. A 1-5/16-inch pin is cut from 1/16-inch brass welding rod or a nail, and is soldered in the hole in the plunger.

The single-frame release receptacle on the side of the camera is removed and soldered over the nubbin at the end of the solenoid. The hole in the receptacle will have to be enlarged to allow the plunger pin to pass. Since the receptacle is plated brass, the plate material must be filed or sanded off before soldering to the solenoid.

The plunger must move freely in the solenoid so the pin can contact the single-frame release inside the camera. If the pin rubs against the sides of the solenoid the hole can be drilled larger. With the plunger all the way in the solenoid, the pin should stick out about 3/8 inch. This is a little longer than necessary, to allow for some adjustment.

The plunger is held inside the solenoid by a "stop" made from aluminum (1/16 x 1 x 1-1/2 inches) bent to an "L" shape. A piece of cork is glued to the end of the plunger to reduce noise. Two holes are drilled on the side of the solenoid for No. 8-32 screws to hold the stop in place. Screw holes in the aluminum stop are made oblong to allow for adjustment of the plunger.

Solenoid Adjustment

The camera is activated by connecting the leads to a 6-volt power source. The solenoid is screwed into the single-frame release hole on the side of the camera. The plunger is slowly pushed until a single frame is released. This should happen when the plunger is almost at the end of its travel. If a frame is released before the plunger is more than 1/16 inch from the end of the solenoid, the pin is too long. Adjustment is made by filing the pin. For smooth operation the pin should be sanded round at the end.

The camera stop is positioned against the plunger when the pin is just touching the single-frame release. It is important the stop does not hold the plunger too far into the solenoid. The plunger is slowly pushed until a "buzz" or slight click is heard. A noise indicates electrical contact has been made and the camera is drawing current. When contact

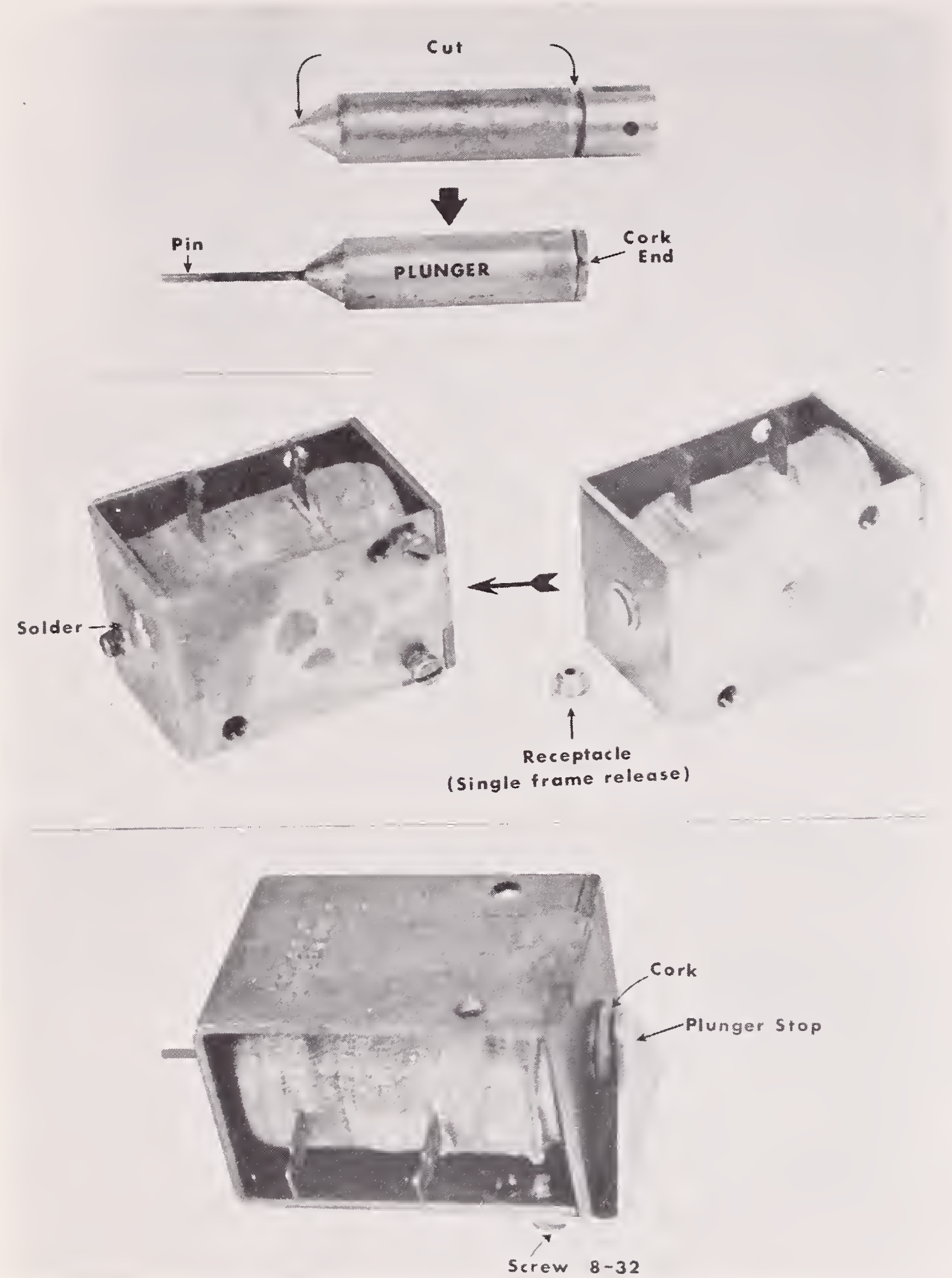


Figure 5.—

Modification of solenoid for activating single-frame release.

is made the plunger should be backed off about 1/16 inch. The stop then can be tightened so the plunger is not held past this point.

Electronic Timer Adjustments

Light entering the photo cell determines when the unit will turn on and off. To change the sensitivity of the cell, the resistance of R 17 is increased by 100 ohm increments so the timer will work under lower light conditions or vice versa. The value given (3.3K) allows the camera to operate at light levels compatible with KK II movie film. When using film with a higher ASA rating for low light levels, the value of R 17 must be increased; otherwise the camera will turn off in light that will still produce a good image.

Voltage to the solenoid is controlled by a resistor (R 25) mounted on the control panel and can be varied by about 1.5 volts. If the plunger is pulled too hard against the single-frame release it can damage the control mechanism inside the camera. Changing the voltage changes the force of the plunger against the single-frame release.

A button cell on the control panel will interrupt the timing cycle and activate the solenoid. When the time interval is set below 3 minutes the solenoid will engage instantaneously. As the time interval is increased the button cell must be held down longer to activate the solenoid.

The timing interval between pictures is changed by turning the adjusting screw on R 1. Clockwise increases and counterclockwise decreases the time. With one 5 mfg capacitor (C 2), the time interval is from 2.5 to 40 minutes. Two capacitors (C 2 and C 3) will change the interval from 4.5 to 60 minutes.

Approximate adjustment for a given time interval for one and two timing capacitors is as follows:

Turns, R-1	One capacitor, C-2	Two capacitors, C-2, C-3
	--- (Minutes) ---	
0	2.5	4.5
5	3.5	6.5
10	5.5	10.5
15	15.0	26.0
17	40.0	60.0

The figures are not exact, and will vary for each timer because of varying tolerance of different parts. Experience indicates the timer is correct at a given interval within 5 percent. Temperature will have some influence on operating characteristics. Good time intervals with less than 5 percent error can be expected between freezing (32° F) and 100° F.

Power Supply

Any 6- to 8-volt battery with 2 amp capacity will operate the camera unit. The camera timer without the solenoid engaged draws between 4 and 8 milliamps. With the solenoid engaged the unit draws 1.8 amps. Average current drain is determined by length of time the solenoid is engaged, time interval, and hours of operation.

Field tests indicate that, with a 5-minute time interval, an engagement time of 0.8 second, and 12 hours of operation, one Eveready No. 1461 battery will last for two rolls of film (approximately 50 days) but each unit will vary. A convenient power supply can be made by connecting two batteries in parallel and enclosing them in a surplus 50-mm ammo cartridge case. A 2-conductor cable with a banana plug on each end provides the connection between camera and power supply.

The Eveready No. 1461 is a dry cell battery and cannot be recharged. A 6-volt, 10-amp motorcycle battery makes a good power supply where longer life and a rechargeable battery are more convenient. In weather below freezing it is best to use a 12-volt lead acid battery which provides extra power. With this power supply the center must be tapped for 8 volts to operate the camera. In no case should more than 12 volts be connected to the timer or more than 8 volts to the camera.

Photographic Factors

Super 8-mm film is available in 50-foot cartridges in four different types: two color and two black and white. KK-II comes in daylight ASA 25, and Type A, ASA 40 for photoflood use. Plus X black and white reversal has a daylight speed of 50. Kodak tri-X reversal is the fastest with ASA 200. Color film provides more detail than black and white film, and is best to use for research purposes.

Number of days that one roll of 8-mm film will last depends on time interval and number of daylight hours of operation:

Time interval (Minutes)	Days of operation 10-hour day	12-hour day	14-hour day
5	30	25	21
10	60	50	43
15	90	75	64
20	120	100	85

For values not included, use the following formula:

$D = 60/(H/I)$

where

D = days for one roll of film

I = time interval in minutes

H = hours of daylight

The formula is based on a 50-foot roll of film with 72 frames per foot, to give 3,600 frames per roll.

Film can be examined several ways. A quick review can be made with an 8-mm film editor. For more detail, individual sections can be examined through a low-power binocular scope on a small light table. Some interesting visual effects can be obtained by viewing the film with a movie projector set at slow speed.

Certain uses of time-lapse photography will require a known time for individual frames. The easiest method is to place a clock in the lens field so its image will appear in the corner of a frame.

Hints for Good Results

The time-lapse camera should work properly if constructed without major change. Many combinations of solenoids, trip mechanisms, and timers were tested before arriving at a final design. The most difficult task in getting the camera to operate properly is in adjusting the solenoid. Before data are collected for research purposes, the unit should be allowed to operate continuously for several days.

Sometimes scratches or a slight "nick" in the solenoid plunger will cause a malfunction. It should be rubbed with a very fine emory cloth and then coated with graphite, teflon, or silicon lubricant. A malfunction can occur with the single-frame release inside the camera. In such cases the camera should be sent back to the factory for repair. It is wise to check a new camera completely so malfunctions can be corrected under warranty. Once the camera is modified, most companies will not honor the guarantee and will charge for repair.

When operating the camera in the field it should be placed on an immovable post or tree. The shutter speed is low (1/30 second), and any movement will cause an image blur when the single-frame release is used.

Moisture inside the camera could be a problem at certain times of the year. Fogging of the lens does occur and small bags of desiccant will help to prevent moisture from accumulating.

Amount of film exposed is shown by an indicator on the side of the camera. Footage must be read before removing film from the camera. When the film case is removed the indicator automatically returns to zero. To check the footage in the field, the camera has to be removed from its case. An alternative is to include a view window in the case during construction.

Since the solenoid must be removed each time the film is changed, it is best not to twist the solenoid too tight. The solenoid should be tightened only for a snug fit.

There are several additional features of this particular time-lapse unit that can be of use to the researcher. Time intervals from 1/2 second to 2-1/2 minutes are possible by making a direct connection across the reset button and adjusting the turns on R 1 to obtain the desired interval.

Another useful feature is exposure of more than one frame in short bursts. This is accomplished without the use of the solenoid. The positive wire from the camera is connected to the positive wire going to the solenoid from the emitter of Q 13. After this is done the camera trigger is pulled back and locked in the "on" position. The number of frames per "burst" is approximately 12.

Noise from activating the solenoid can be reduced by placing styrofoam inside the aluminum case. With some cutting the same styrofoam that came with the camera can be used effectively.

Component Suppliers

Most of the parts listed in tables 1 and 2 can be purchased from local stores or obtained from surplus equipment. Listed below are addresses of some companies that have components for the time-lapse unit.

Electronic components:

Allied Electronics
100 N. Western Av.
Chicago, Ill. 60680

Newark Electronics Corp.
500 N. Pulaski Rd
Chicago, Ill. 60624

Lafayette Radio Electronics
111 Jerico Turnpike
Syosett, L. I.
New York, N. Y. 11791

Aluminum boxes:

Zero Manufacturing Co.
1121 Chestnut St.
Burbank, Calif. 91503

Capacitors EEC B42A505K

Engineered Components Co.
2134 West Rosencrans Av.
Gardena, Calif. 90249

Total cost of parts, including camera, is approximately $165. Other cameras with a single-frame release can be used and may be more desirable depending on individual needs. Prices of different makes of cameras will vary from $100 to $150.

Agriculture—CSU, Ft. Collins

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1972. Construction of an 8-mm time-lapse camera for biological research. USDA Forest Serv. Res. Pap. RM-88, **8** p. Rocky Mt. Forest and Range Exp. Stn., Fort Collins, Colo. 80521.

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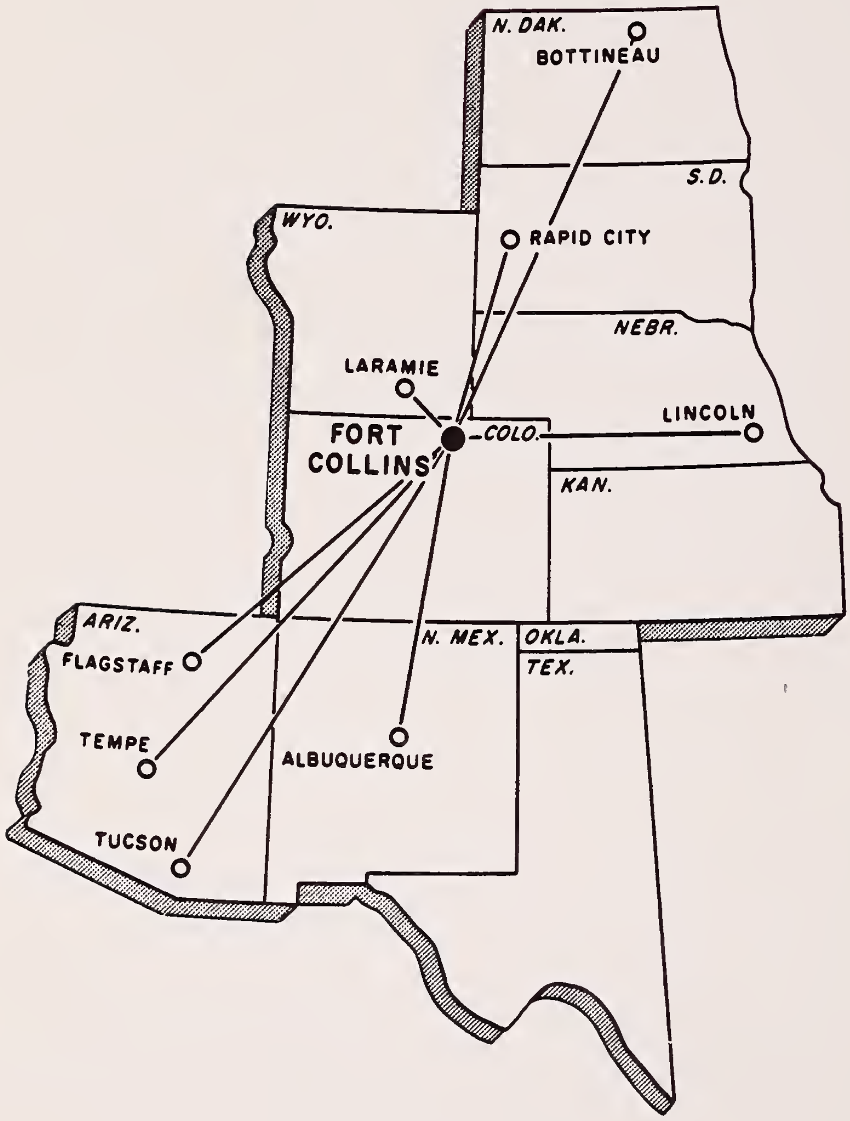
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